UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/661,831	09/12/2003	Qing Hu	101328-0178	7713

21125 7590 03/24/2006

NUTTER MCCLENNEN & FISH LLP
WORLD TRADE CENTER WEST
155 SEAPORT BOULEVARD
BOSTON, MA 02210-2604

EXAMINER	
VAN ROY, TOD THOMAS	

ART UNIT	PAPER NUMBER
2828	

DATE MAILED: 03/24/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/661,831	HU ET AL.	
	Examiner	Art Unit	
	Tod T. Van Roy	2828	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *13 January 2006*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-28* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-28* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

The examiner acknowledges the amending of claims 1, 24-25, as well as the addition of claims 27-28, and the filing of a terminal disclaimer.

Response to Arguments

Applicant's arguments with respect to claims 1-26 have been considered but are moot in view of the new ground(s) of rejection.

The examiner agrees that the claims, as amended, overcome the previous rejections that relied upon Xu, Kohler, Williams, and Goodhue.

The action is made non-final as claim 27 is largely the same as the combination of previous claims 1 and 3. The examiner agrees with the arguments presented by the applicant with regards to previous claim 3.

Claim Objections

Claim 27 is objected to because of the following informalities:

The language "...wherein the laser is capable of generating lasing..." found in claim 27 is objected to as being vague and indefinite. The examiner suggests changing the claim language to state "...wherein the laser *generates* lasing...".

Appropriate correction is required.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

Claims 1-2, and 4-26, are rejected under 35 U.S.C. 102(a) as being anticipated by Williams et al. (Williams et al., "3.4-THz quantum cascade laser based on Longitudinal-optical-phonon scattering for depopulation," Appl. Phys., Leo. 82. 1015 (2003)).

With respect to claim 1, Williams discloses a quantum cascade laser, comprising a semiconductor heterostructure providing a plurality of lasing modules connected in series (col.3 para.1), each lasing module comprising a plurality of quantum well structures collectively generating at least an upper lasing state, a lower lasing state, and a relaxation state (fig.1a) such that said upper and lower lasing states are separated by an energy corresponding to an optical frequency in a range of about 1 to about 10 Terahertz (abs.), and such that a radiative lasing transition between said upper lasing and said lower lasing state is spatially vertical (col.2 para.2) and wherein electrons populating said lower lasing state exhibit a non-radiative relaxation via resonant emission of Lo-phonon into said relaxation state (col.2 para.2) such that a ratio of a lifetime of said upper lasing state relative to a lifetime of said lower lasing state is at least about 5 (col.2 para.2, upper/lower=12.9).

With respect to claim 2, Williams discloses the quantum cascade laser of claim 1, wherein said non-radiative relaxation of the lower lasing state into the relaxation state at a selected operating temperature of said laser is faster than a corresponding relaxation rate of said upper lasing state into said lower lasing state (col.2 para.2 T4-(1,2) faster

than T5-(1,2)), and wherein said resonant Lo-phonon emission selectively depopulates the lower lasing state such that a ratio of a lifetime of said upper lasing state relative to lifetime of said lower lasing state is at least about 10 (col.2 para.2, t4=0.55ps, t5=7.1ps, t5/t4=12.9).

With respect to claim 5, Williams discloses the cascade laser to operate in pulse mode (col.3 para.2).

With respect to claim 6, Williams discloses the cascade laser to comprise an electrical contact for applying a bias voltage across the heterostructure (col.3 para.1).

With respect to claim 7, Williams discloses that the bias voltage causes a relaxation state of each lasing module to be in substantial resonance with an upper lasing state of an adjacent module to allow resonant tunneling of electrons there between (col.1 para.1).

With respect to claim 8, Williams discloses that electrons populating an upper lasing state of each module exhibit a vertical optical transition into a lower lasing state of the module (col.2 para.2).

With respect to claim 9, Williams discloses the quantum cascade laser of claim 1, wherein in each of said lasing modules, said relaxation state is characterized by a wavefunction exhibiting substantial amplitude in a first one of said quantum wells (fig.1a), said upper lasing state is characterized by a wavefunction substantially concentrated in quantum wells other than said first quantum well (fig.1a), and said lower lasing state exhibiting sufficient amplitude in said first quantum well so as to cause a

substantial phonon coupling between said lower lasing state and said relaxation state (col.2 para.2).

With respect to claim 10, Williams discloses said upper and lower lasing states to exhibit substantial amplitudes in at least one of said quantum wells (fig.1a) so as to allow a vertical optical transition between said upper and lower lasing states (col.2 para.2).

With respect to claim 11, Williams further discloses said quantum wells generate a fourth state in substantial resonance with said lower lasing state upon application of said bias voltage (fig.1a).

With respect to claim 12, Williams further discloses the electrons populating said fourth state exhibit relaxation via resonant LO-phonon scattering into said relaxation state (col.2 para.2).

With respect to claim 13, Williams discloses the cascade laser to comprise an upper contact layer and a lower contact layer between which said semiconductor heterostructure is disposed (col.3 para.1).

With respect to claim 14, Williams discloses the heterostructure to be formed of a stack of alternating GaAs and Al(0.1)Ga(0.85)As layers (col.2 para.2).

With respect to claim 15, Williams discloses the heterostructure to have a thickness in a range of about 1 to about 10 um (fig.1a)

With respect to claims 16-17, Williams discloses the contact layer to be formed of heavily doped GaAs with a doping level of about 3x10^18 (col.3 para.2).

With respect to claim 18, Williams discloses a waveguide coupled to said heterostructure for confining selected lasing modes of said laser (col.3 para.2)

With respect to claim 19, Williams further discloses said waveguide is formed of a metallic layer (upper) and a heavily doped semiconductor layer (lower) between which said semiconductor heterostructure is sandwiched (col.3 para.2).

With respect to claim 20, Williams further discloses the waveguide is formed of two metallic layers between which said semiconductor heterostructure is sandwiched (col.3 para.1, metal and quasimetallic).

With respect to claim 21, Williams discloses the number of lasing modules to be within a range of about 100 to about 200 (col.3 para.1, 175 periods).

With respect to claims 22-23, Williams discloses the cascade laser to be formed on a semi-insulating GaAs substrate (col.3 para.1).

With respect to claim 24, Williams discloses the cascade laser as outlined in the rejection to claim 1, wherein the laser would inherently function as an amplifier to incoming radiation in the 1 to 10 THz range, and additionally an input port and output port would be located at either facet of the device.

With respect to claim 25, Williams discloses a quantum cascade laser of claim 1, comprising a semiconductor substrate (col.3 para.1).

With respect to claim 26, Williams discloses the phonon scattering rate of electrons from the lower lasing state to the relaxation state to be in the range of about .1 to about .6 ps (col.2 para.2, 0.55ps).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claim 28 is rejected under 35 U.S.C. 103(a) as being unpatentable over Williams.

With respect to claim 28, Williams teaches the quantum cascade laser as outlined in the rejection to claim 1, and additionally teaches the oscillator strength to be sufficient in order to have significant gain (col.1 para.1). Williams does not teach the strength to be about unity. It would have been obvious to one of ordinary skill in the art at the time of the invention to infer the "sufficient oscillator strength" teaching of Williams would imply a value close to unity, as this is the peak strength value and would lead to the highest amount of gain.

Claims 3 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Williams in view of Williams(2) et al. (Williams et al. "3.4 THz quantum cascade laser operating above liquid nitrogen temperature" Elec. Letter., Vol. 39, No. 12 (06/12/2003)).

With respect to claims 3 and 27, Williams teaches the cascade laser as outlined in the rejection to claim 1, but does not teach the laser to generate radiation at temperatures above about 87K. Williams(2) teaches a cascade laser which operates at temperatures above about 87K (abs.). It would have been obvious to one of ordinary skill in the art at the time of the invention to combine the cascade laser of Williams with the operating temperature of Williams(2) in order to provide for a device that does not require additional *extreme* low temperature cooling equipment to be used in conjunction with its operation.

Allowable Subject Matter

Claim 4 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter:

Claim 4 is believed to be allowable as the prior art was not found to teach a quantum cascade laser operating in the 1-10 THz range that operates above about

130K. The prior art cited both in this action, and the previous, teach vary low temp operation when this wavelength regime is utilized (anywhere from 5-80K), and higher temps when mid-infrared regimes are used (hundreds of K, near and above room temp). It is not found to be obvious to combine the different wavelength regimes together, as noted by the applicant (see Remarks), as fundamental device operation and structural features vary between these devices.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tod T. Van Roy whose telephone number is (571)272-8447. The examiner can normally be reached on M-F.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Minsun Harvey can be reached on (571)272-1835. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

TVR